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Anisotropic neutron emission spectrum and its utilization for verification of nuclear elastic scattering effect in proton-beam-injected deuterium plasmas

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It is well known that the nuclear elastic scattering (NES) contributes to the slowing-down of suprathermal ions in thermonuclear plasmas [1]. So far several calculations have predicted that ion heating by energetic ions, i.e. transferred power from energetic to bulk ions, is enhanced due to NES [2,3]. NES can also modify the fusion reaction rates [4]. It is important to experimentally ascertain the phenomena concerning plasma-heating process and validate the numerical simulations for fusion plasma operation and control. An observation scenario of knock-on tail due to NES by looking at the change of the γ-ray emission rate from 6Li+d reaction in a proton-beam-injected deuterium plasma has been proposed [5] and the experiment is just planning on Large Helical Device (LHD) at NIFS. When knock-on tail is created in deuteron velocity distribution function due to NES, the neutron emission spectrum by D(d,n)3He reaction is also modified from Gaussian distribution function with enhancement of the neutron emission rate itself from the value for Maxwellian plasma.
In this paper, the modification of the neutron emission rate and the double differential emission spectrum that will appear at the same time in the previously proposed experiment [5] are examined considering spatial ion behaviors in magnetic configuration [6]. We newly propose an observation scenario of knock-on tail using anisotropic neutron emission spectrum in proton-beam injected deuterium plasmas. It is shown that the modification of the emission spectrum is significant and non-Gaussian component appears approximately more than ˜1/50 orders compared with the Gaussian peak. We also discuss a possible scenario for knock-on tail observation using both anisotropic, i.e., non-Gaussian, neutrons and γ-rays at the same time.

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Eligible for student paper award?

No

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